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POPULATIONS OF THE DEER-MOUSE AND ASSOCIATED SMALL
MAMMALS IN THE MESQUITE ASSOCIATION OF
SOUTHERN NEW MEXICO

BY W. FRANK BLAIR

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INTRODUCTION

THE size of the home range and the rate of dispersal of a species must be learned before any attempt can be made to determine the rate at which local races of that species originate. Population size, rate of increase, and social relations within the species also are important because of their possible effects on the origin of local races.

As a part of an attempt to learn the rate of origin of local races of deer-mice in the southwestern United States, live trapping and marking operations were carried out in the mesquite association near Alamogordo, New Mexico. The trapping was begun on March 4, and the field work was brought to a close on May 24, 1940. During the course of operations, 105 Chihuahua deer-mice (*Peromyscus maniculatus blandus*) were marked and retrapped many times, and, in addition, 419 other small mammals comprising ten species were marked and observed.

It became evident soon after the work was begun that the trapping data would be adequate for a study of the home ranges and size of populations of nearly all of the small mammals on the trap areas. A technique for studying dispersal, successful in other areas, proved inadequate in this region (see p. 15), and the data here presented consequently deal largely with home-range size and features of population dynamics other than dispersal.

ACKNOWLEDGMENTS

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field assistant. Climatological data were furnished by the United States Weather Bureau. Publication was made possible by a grant from the Horace H. Rackham School of Graduate Studies.

THE MESQUITE ASSOCIATION

The principal vegetative features of the mesquite association of the Tularosa basin were described briefly but succinctly by Ruthven (1907: 495), who stated that "the flora consists principally of the mesquite (with some crucifixion thorn)." Dice (1930: 9) gave a more extensive description of the mesquite association and mentioned the presence of several species of *Atriplex* and a species of *Lepidium*, in addition to the plants mentioned by Ruthven.

The mesquite was by far the most abundant and most conspicuous plant on the area studied by me. In fact, all of the other plants could have been removed without altering materially the appearance of the vegetation. The habit of growth of the mesquite varied greatly. Some mesquites were small trees, ten to fifteen feet high. Others formed dense, shrubby masses of varying heights, and there were extensive areas of closely spaced, short, relatively straight mesquite stems, usually less than two feet in height. These last possibly were maintained in this condition by browsing cattle. Many mesquites and the crucifixion thorns were considerably affected by browsing. The clumps of mesquite alternated with barren areas on which there was little or no vegetation. The distance between clumps varied greatly. Around many of the clumps the accumulation of wind-blown sand and dust had built up mounds from a few inches to two or three feet high.

There were a few crucifixion thorns (*Koeberlinia spinosa*) and a few atriplex (*Atriplex canescens*). In April and May there were a few herbs, the most abundant being *Lepidium alyssoides*. Less numerous were *Astragalus nuttallianus*, *Verbena wrightii*, *Gilia pumila*, and *Sophia* sp.

In addition to the specimens of eleven species of small mammals caught, several species too large for our traps were known to frequent the areas trapped. Cottontails (*Sylvilagus audubonii minor*) were fairly numerous, and an occasional jack rabbit (*Lepus californicus texianus*) was seen. Coyotes (*Canis latrans*) were seen or heard on several occasions, and dogs traversed the area a few times. Deer tracks were seen once. Cattle were being "grazed" on the area when trapping was begun, but they had been removed before the end of the field work.

Food for the mammals of the mesquite association was limited during approximately the first half of the field period. The previous year's crop of mesquite beans and herbaceous seeds seemed to have been exhausted long before March. The only appreciable source of food appeared to be the bark of the mesquite. Many of the mesquite stems evidently had been gnawed near the ground. When a clump of mesquite was trampled to the ground, virtually all of the stems were gnawed clean of their bark before the next

morning. After the spring growth began, the leaves and tender shoots of the mesquite and the fruit and foliage of *Lepidium alyssoides* probably provided the bulk of the food supply. On numerous occasions the small mammals carried these into the traps and there abandoned them in favor of the apparently more desirable sunflower seeds used as bait. The traps were baited liberally, and the Heteromyid rodents, after gorging themselves, filled their cheek pouches with sunflower seeds which they, when released, carried away and cached. After trapping had been under way for some time, the small piles of hulls indicative of these caches were numerous on the plots. Sometimes they were near mesquite clumps, sometimes in the barren areas intervening between the clumps. Possibly the caches in the open areas were safer from discovery by other individuals than those near the mesquites.

A great abundance of refuges and possible homesites was an important feature of the mesquite association. Nearly every clump of mesquite had one or more series of pocket-mouse or kangaroo-rat tunnels. Many of these, of course, were occupied by their builders or their descendants. Many others, however, were old tunnels that provided shelter for deer-mice, wood mice, or grasshopper mice. In addition to these multitudinous small holes and tunnels there were large abandoned holes that presumably had been dug by skunks and badgers. There also were some abandoned wood-rat dens and ground-squirrel holes. Because of this abundance of holes and tunnels, a small mammal that was released from a trap in any part of its home range usually was able to take refuge in a hole at the nearest mesquite clump.

The weather deviated slightly from the normal during the field period. The mean temperature for each month was slightly warmer than the average for these months (Table I). Precipitation was below normal in March and April, and considerably above normal in May.

TABLE I
CLIMATOLOGICAL DATA FOR ALAMOGORDO WEATHER STATION, No. 1,
FOR MARCH, APRIL, AND MAY, 1940

Month	Temperature F.						Precipitation		No. of Days Clear or Cloudy		
	Mean	Departure from Normal	Mean Max.	Mean Min.	Highest	Lowest	Total	Departure from Normal	Clear	Partly Cloudy	Cloudy
March	55.4	+2.5	69.6	41.2	82	24	0.10	-0.49	22	8	1
April	62.3	+2.2	77.8	46.8	88	32	0.01	-0.53	19	8	3
May	71.8	+3.1	86.2	57.5	94	48	2.09	+1.61	16	11	4

METHODS

The methods used in this study are in general those that have been developed in previous studies of home ranges and populations of small mammals (Blair, 1941a). Several modifications in technique, however, have been necessary because of local conditions.

PLOTS

Trapping was begun on a plot comprising 18.83 acres of mesquite association on March 4, 1940. Before the traps were set the plot was staked out in a grid pattern with the stakes forty-five feet apart. The traps were set out in lines that roughly followed the lines of stakes, although the traps were set at the stakes only where these were at or near the mesquite clumps, since small mammals of this association frequent these clumps and usually cross the intervening barren spaces only in moving from one clump to another. In general, a trap was set at each mesquite clump along a line of stakes, and two traps sometimes were used at large clumps. It soon became evident that the traps were more closely spaced than was necessary, and at the end of March alternate lines of traps were removed from the plot and used in another plot. After this change, plot A comprised 18.07 acres. The center of the second plot (plot B) was about one-half mile from the center of the first and comprised 17.69 acres (Fig. 1). This plot was staked out with the stakes forty-five feet apart in the lines, but with the lines ninety feet apart. The traps were spaced approximately the same on both plots and were maintained in this pattern until the end of trapping on May 24, 1940.

In outside dimensions plot A was 1215 feet long by 675 feet wide in March, and 1215 feet long by 648 feet wide in April and May. Plot B was 1044 feet long by 738 feet wide. These measurements were made from the outer traps on each side.

TIME INTERVALS

Both plots were divided into halves lengthwise, and one-half of each plot was trapped at a time. At the beginning, one-half of plot A was trapped for a week. After the first week, however, the trapping routine was altered slightly. With the new routine one-half of the plot was trapped for six days. On the seventh day the traps on only the outer half of this half-plot were set, and in addition the traps on the outer half of the other half-plot were set. Then the traps on the second half of the plot were set for the five following days. With this routine, in the course of twenty-five days each half of the plot was trapped for one five- and one six-day period. In addition, an outer one-fourth on each side of the plot was trapped on the three days intervening between the regular trap periods. This seemingly complicated, although really simple, trapping practice was devised to ensure the capture of each small mammal in as many parts of its home range as possible.

A small mammal often will enter the first trap that it encounters after leaving its domicile. This procedure was in part eliminated by leaving a

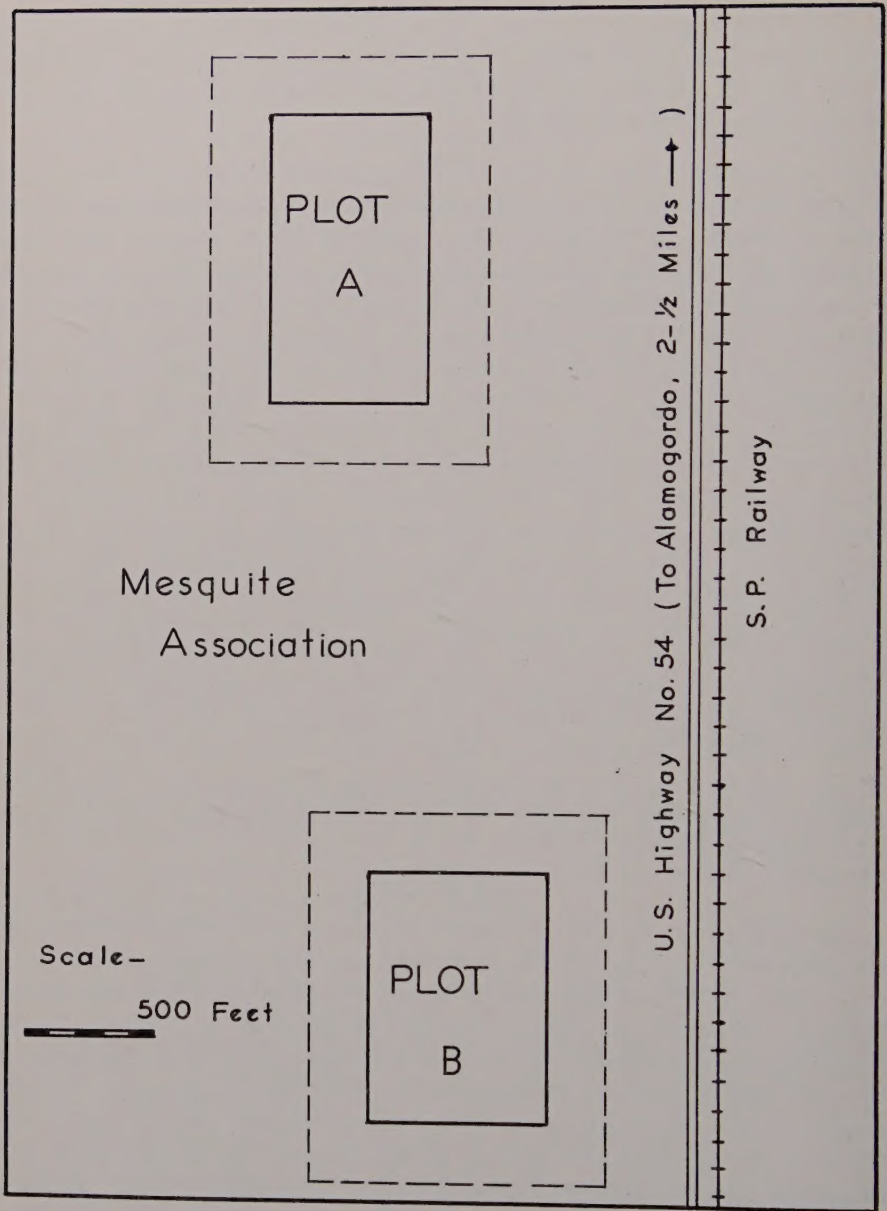


FIG. 1. Trapping plots in mesquite association near Alamogordo, New Mexico. Solid lines enclose areas on which traps were set. Broken lines enclose calculated areas from which mature male deer-mice were effectively trapped.

trap unset on the night following two consecutive captures of the same individual. There was always the possibility, however, that the animal would then be caught in the next adjacent trap. Therefore, the above described method for trapping different parts of the plot at different times was devised. The problem of localization of small mammal movements was recognized by Chitty (1937: 44), who moved his traps in a rectangular pattern every night. Such a solution would have been physically impracticable in the present investigation.

Three different time intervals have been used in treating the various data:

“Trap month.” This comprises the twenty-five-day period required to run through the trapping routine described above. One of these periods was completed in each month from March through May. In referring to these periods, only the month will be mentioned. The March period extended from March 4 to 29, the April period from April 1 to 25, and the May period from April 30 to May 24. The March period exceeded the others by one day, because of the full week of trapping at its beginning.

“Half month.” This is the period for which calculations of populations and of concentrations were made. In the calculations the first twelve days of the “trap-month” period are considered one “half-month” period, and the last thirteen days are considered another. These periods will be mentioned as the first half and the last half of the respective months.

“Trap period.” This period has been used only in summarizing the breeding records of the males. It includes the consecutive days on which one-half of the plot was being trapped, including the “change-over” day on which only the outer traps were set. There are seven days in each period, since there is an overlap of one day in consecutive periods because of the change-over day on which traps were set on only half of each half plot. This overlap is made necessary by the method used in keeping field notes on breeding.

TRAPPING METHODS

The traps were of a standard type with a pressed-wood box large enough to accommodate kangaroo rats and spotted ground squirrels (Blair, 1941b). Sunflower seeds were used as bait, and each trap was provided with cotton nesting material.

The traps were set shortly before dark in the evening and usually were run shortly after daylight. On a few of the coldest nights the traps were run between 10 P.M. and 1 A.M., and those that contained mammals were left unset after the captures had been released. All of the mammals were removed from the traps and were then marked, recorded, and released at the point of capture. The traps were left unset during the day because of the sun's heat.

The mammals were marked by the ear-punching and toe-clipping method, except for the pocket mice, on which only the toes were clipped.

METHOD OF CALCULATING HOME-RANGE AREA

A previously used method for calculating home-range areas (Blair, 1940a) was slightly modified, because here the traps necessarily were spaced irregularly instead of in a grid pattern. The outer limits of a given home range were drawn one-half the distance between the outer traps in which the animal was caught and the next adjacent traps. This is the same as was done when traps were set in a grid pattern. The only difference is that in this investigation the distance between any two pairs of traps seldom is the same.

Some animals will have ranges that extend beyond the limits of any plot. To eliminate most of the fractional ranges, the ranges of individuals that were caught only in a strip 180 feet wide around the outer edges of the plots were arbitrarily excluded from the computations of average home-range size. Some of the included ranges, however, extended to the outermost lines of the plots and may have continued beyond the edge of the plot. To have excluded them would have eliminated some of the largest ranges.

In computing home-range size, the trap month (see p. 7) has been used as the temporal basis for the calculation of home ranges. In the case of an individual who moved to a plot near the end of a trap month, the data for the last trap period (seven days) of that month have been added to those for the following month. Likewise, if an individual disappeared from a plot shortly after the beginning of a trap month, the data for the first trap period of that month have been added to those for the previous month. In no case have the data for more than one trap period been added to a trap month.

Many of the small mammals caught on the plots were taken so few times that their complete home ranges obviously were not learned. Consequently, all home ranges based on less than the arbitrary number of ten captures were eliminated as incomplete, except in the case of the rare species, where the data have been recorded for what they show of home-range size.

It was determined also whether or not each range calculated on ten or more captures ceased to increase in size before the last capture on which it was based. Only in the case of the female *Perognathus penicillatus* did all of the ranges cease to increase before the last capture (Table II). In the other classes, up to 20 to 40 per cent of the ranges increased slightly on the last time of capture. When the ranges that ceased to increase before the last capture were tabulated separately from those that increased with the last catch, however, there was no significant difference between the means. This, with the enormous range of variation in the number of captures necessary before a range ceased to increase (Table II), has led me arbitrarily to include in the calculations all ranges based on ten or more captures.

Haugen (MS), using a very different spacing of traps and a different method of computing home-range size, apparently found more uniformity in the number of captures necessary to show the complete home range of a cottontail than is evident in my data. It is not surprising to me to find such

TABLE II
CAPTURES PER TRAP MONTH AS BASIS FOR CALCULATIONS OF AVERAGE HOME-RANGE SIZE

Species	Sex	Ranges Based on Ten or More Captures		Ranges That Ceased to Increase Before Last Capture		Ranges That Increased with Last Capture of Month		Extremes	
		No.	Average Captures	No.	Average Captures	No.	Average Times Caught	Earliest Capture after Which Range Did not Increase	Latest Capture after Which Range Did not Increase
<i>Peromyscus maniculatus blandus</i>	♀ ♂	21 31	17.5 18.8	13 19	13.8 16.8	8 12	15.1 17.1	6 7	20 30
<i>Peromyscus maniculatus blandus</i>	♀ ♂	6 10	12.7 14.7	6 8	10.5 11.1	 2	 15.0	5 7	14 19
<i>Perognathus penicillatus eremicus</i>	♀ ♂	26 32	16.0 17.1	19 21	13.5 14.0	7 11	14.7 17.1	7 6	23 25
<i>Dipodomys ordii ordii</i>	♀ ♂	35 57	17.4 16.6	21 35	15.9 14.3	14 22	15.6 15.7	9 8	21 24
<i>Dipodomys merriami ambigua</i>	♀ ♂								
<i>Dipodomys merriami ambigua</i>	♀ ♂								

a great variation in the number of times that a small mammal must be trapped before its calculated home range ceases to increase. The area of a home range reflects many normal as well as what might be termed abnormal movements of its possessor. If an animal ranges widely on the first few nights of trapping, and, for some reason, less widely during later trapping, its calculated range may not increase after the first few times it is caught. If, on the other hand, the animal for one of many possible reasons does not venture far from its domicile during the first few nights of trapping and later ranges more widely, many captures may be necessary before its calculated range ceases to increase. In fact, its range may not be entirely defined in the limited time in which home ranges usually must be calculated.

In the statistical treatment of home-range size, standard errors rather than probable errors have been used. In comparing two means, a difference of 2.7 or more times its standard error is considered significant.

METHODS OF CALCULATING POPULATIONS AND CONCENTRATIONS

In calculating population density it has been kept in mind that many animals caught on a plot have ranges that extend beyond the limits of the trapping area. Therefore, one-half the width of the average home range has been added on each side of the plots to determine the area effectively trapped. Estimates of population density based on the area effectively trapped are consistently smaller and more accurate than those based merely on the area on which traps were set. One example should suffice to show the necessity for basing population estimates on the area effectively trapped. On plot B male Chihuahua deer-mice were being effectively trapped from a calculated area of 40.8 acres; but the traps were set out over an area of only 17.7 acres. On the same plot female deer-mice were being effectively trapped from a calculated area of 39.0 acres.

In computing concentration, the number of average home-ranges for each sex, age class, and species of mammal under consideration on the area effectively trapped is determined. Then, it is a simple matter to determine the concentration or average number of individuals per average home-range area.

AGE CLASSES AND BREEDING CRITERIA

Four age classes were recognized. Juveniles were those still completely in juvenile pelage. Subadults were those in which the juvenile pelage was being replaced by the first adult pelage. Young adults had the first adult coat, but they had not yet reached their full growth. Adults were fully mature in size. The age class determinations of the *Peromyscus* were more critical than were those of the other mammals because of my greater familiarity with all ages of these mice. For the purpose of summarization the juvenile and subadult classes in some parts of the text have been combined as an immature class. Young adults and adults have been combined as matures.

The location in the scrotum of testes large enough to be discerned by palpation was considered evidence of breeding activity of this sex. Scrotal testes were classified as large or medium in the field notes, but the two classes have been combined in summarizing the data. If the testes were indiscernible because of their small size, this was taken as evidence of sexual inactivity.

Two criteria of breeding of female Cricetidae were used. Late stages of pregnancy were evident from the external appearance of the females. The condition of the mammae indicated whether or not a female was suckling young. In female Heteromyidae a third clue to sexual activity was available, for a gelatinous plug forms in the vagina of these females following copulation.

SPECIES ACCOUNTS

Peromyscus maniculatus blandus

The Chihuahua deer-mouse was the main object of the study, and, consequently, the plots were laid out in an area that, in the fall of 1938, had the greatest deer-mouse population of any area of mesquite association in the central Tularosa basin. On plot A sixty-six deer-mice were trapped in three months, and on plot B forty-three were caught in two months.

HOME RANGES

The home ranges of neither males nor females showed any significant size variation from month to month. Therefore, the calculated home ranges for each of the three months have been combined to determine the mean monthly home-range size. Thirty-one home ranges of mature males caught an average of 18.8 times per month averaged 4.66 ± 0.33 acres. The largest range of a mature male comprised 9.92 acres in May, and the smallest comprised 2.03 acres in the same month. A mature male that was caught in all three months ranged over 3.53 acres in March, 3.22 acres in April, and 2.71 acres in May. Another male ranged over 8.00 acres in March, 5.76 acres in April, and 5.27 acres in May.

Twenty-one mature females caught an average of 17.5 times per month had an average home range of 4.10 ± 0.39 acres. The largest range of a mature female comprised 8.70 acres in April, and the smallest comprised 1.66 acres in March. The home range of one female that was on plot A during all three months comprised 5.43 acres in March, 5.51 acres in April, and 6.41 acres in May (Fig. 2).

There is no significant difference in the size of the male and the female home ranges. This is particularly interesting because in the subspecies *gracilis* (Blair, 1942) the home ranges of the males are significantly larger than those of the females.

The home ranges of both male and female *blandus* are significantly larger than those of *bairdii* of the blue-grass association in southern Michigan and of *gracilis* of the beech-maple association in northern Michigan. The differ-

ence between the means for mature male *blandus* and *gracilis* is 2.35 ± 0.43 acres. Between the means for mature female *blandus* and *gracilis*, the difference is 2.71 ± 0.42 acres.

The home ranges of both male and female deer-mice overlapped broadly in all of the months of trapping on both plots. This is indicative of wide-

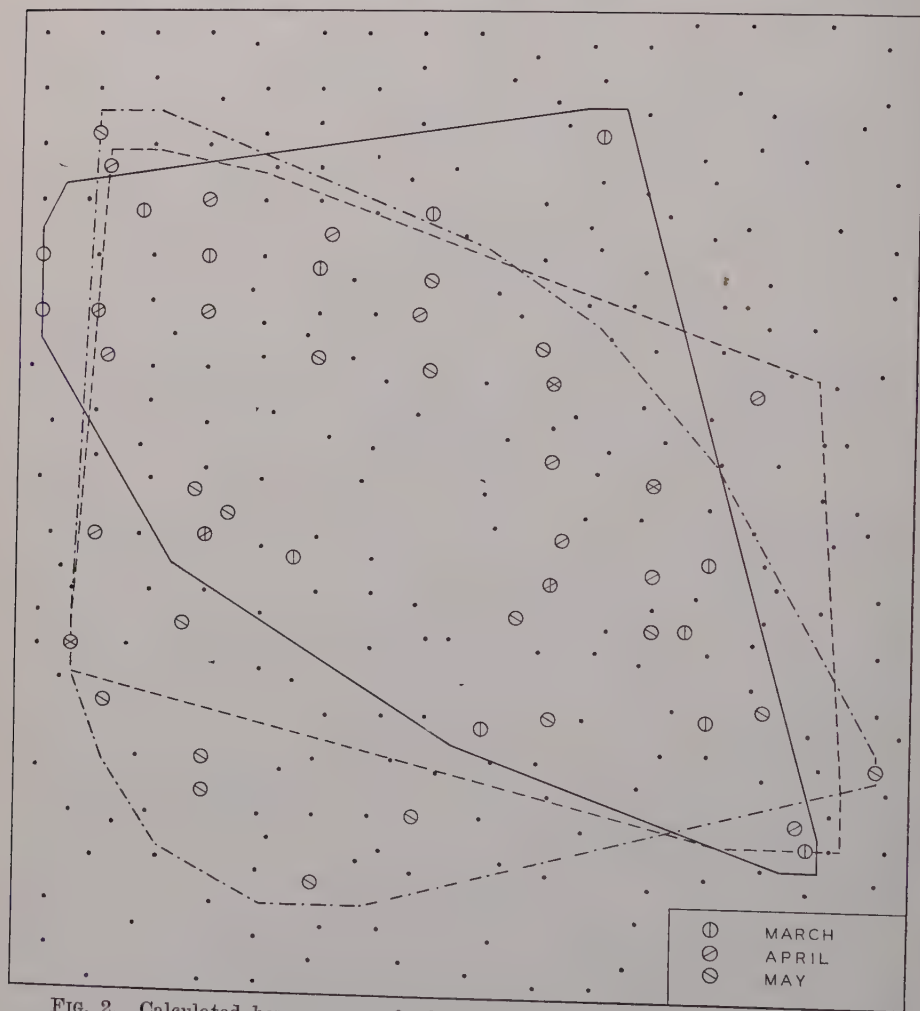


FIG. 2. Calculated home range of adult female deer-mouse in each of three trap months. Dots indicate traps. Circular symbols show traps in which this individual was caught during each trap month.

spread intrasexual tolerance among individual deer-mice. A similar relationship of individual home ranges existed among deer-mice of the subspecies *bairdii* and *gracilis*.

The month to month fluctuations in the home range of one mature female deer-mouse are shown in Figure 2. The general location of the range re-

mained the same in all of the three months. Minor variations occurred, however, in each month. In March this animal ranged farther northeast than in any other month. In May it ranged farther southwest than in the other months. Otherwise, the limits of the monthly ranges differed little. It is interesting that several traps near the center of the range were never entered. The central area possibly was unattractive to this deer-mouse or was avoided for one of several possible reasons. The minor fluctuations in the home range of this individual are representative of those in the home ranges of the deer-mice of the mesquite association.

POPULATIONS AND CONCENTRATIONS

The average number of deer-mice per acre was about the same on both plots A and B. Consequently, the data for both areas have been combined to show the average population density of this species in the mesquite association at the time of the field work (Table III). The greatest density of

TABLE III

AVERAGE POPULATIONS OF DEER-MICE (*Peromyscus maniculatus blandus*) PER ACRE IN MESQUITE ASSOCIATION. TWO PLOTS COMBINED

Class	March 4-16	March 17-29	April 1-12	April 13-25	April 30- May 11	May 12-24
Mature ♀	.14	.27	.14	.25	.20	.23
Mature ♂	.16	.30	.21	.35	.31	.33
Immature ♀ .....	.....	.05	.02	.03	.04	.04
Immature ♂ .....	.....	.05	.04	.....	.....	.03
Totals	.30	.67	.41	.63	.55	.63

mature females, an average of 0.27 individuals per acre, was in the second half of March. The maximum density of mature males was in the second half of April, an average of 0.35 individuals per acre. Most immature deer-mice were caught during the second half of March, when there was an average of 0.10 immatures per acre. The maximum density of all sexes and ages of deer-mice, an average of 0.67 deer-mice per acre, occurred in the second half of March. The drop to 0.41 deer-mice per acre in the first half of April can in large part be explained. In the last half of March a thoughtless hunter set some of our inactive traps on plot A, and before this was discovered several deer-mice entered them and died. The deer-mice of plot A recovered from the loss as other individuals moved to the plot, so that in the last three periods the population density was only a little less than the March maximum.

The data on population density indicate that deer-mice were not numerous at the season that the trapping was being done. The five-toed and four-toed kangaroo rats and the pocket mouse were more numerous than the deer-mouse on plot A, and the last two species outnumbered it on plot B.

The average number of deer-mice per home-range area in each trapping period is listed in Table IV. The data for the two plots have been com-

TABLE IV
AVERAGE NUMBER OF DEER-MICE (*Peromyscus maniculatus blandus*) PER HOME-RANGE
AREA IN MESQUITE ASSOCIATION. TWO PLOTS COMBINED

Class	March 4-16	March 17-29	April 1-12	April 13-25	April 30- May 11	May 12-24
Mature ♀	0.59	1.09	0.57	1.04	0.83	0.93
Mature ♂	0.76	1.41	0.96	1.64	1.41	1.52
Immature ♀ .....	.....	0.19	0.10	0.10	0.14	0.14
Immature ♂ .....	.....	0.19	0.15	.....	.....	0.10

bined. The greatest concentration of mature females was in the second half of March, when there was an average of 1.09 females per home-range area. In only one other period, the last in April, was there an average of one or more mature females per home range. The least concentration of mature females was in the first half of April, when these averaged only 0.57 individuals per home-range area. The greatest concentration of mature males, an average of 1.64 males per home-range area, was in the last half of April. In three other periods there was considerably more than one male per home range. The least concentration of mature males, an average of only 0.76 males per home-range unit, was in the first half of March. The concentration of immature deer-mice always was slight. The greatest concentration of immature males and females combined was in the second half of March, when there was an average of 0.38 immatures per home range area.

BREEDING

A period of little or no breeding activity prior to the initiation of field work in early March was indicated by the fact that no immature deer-mice were caught before the third trapping period in March. In fact, it appears that the trapping was begun, as was planned, at approximately the time the spring breeding season began.

In March seven (64 per cent) of eleven mature females examined appeared to be pregnant or to be suckling young. In April seventeen (77 per cent) of twenty-two mature females appeared at some time to be pregnant or suckling. In May sixteen (67 per cent) of twenty-four mature females appeared pregnant or suckling. This does not mean that most of the females bore litters in every month, for only a few of the females were caught in all three months. One female that was under almost daily observation from the first to the last day of trapping bore three litters during the three months. Another that was observed in all three months apparently bore only one litter.

In the males, general sexual activity was indicated by the enlarged testes.

Only 75 per cent of the mature males were sexually active in the first March trap period. Mature males were all sexually active in all other periods except the third March and second and third May periods. In these last periods, respectively, 87, 87, and 77 per cent of the mature males were in breeding condition. Three subadult deer-mice were in breeding condition, and two juveniles had enlarged testes. Sexual maturity sometimes is attained before the juvenile coat is shed.

That deer-mice breed during the fall in the Tularosa Basin was indicated in 1938, when numerous immatures were caught between October 11 and December 7. There is evidence also that at least some breeding takes place during the summer. Dice (1930: 25) recorded three pregnant females taken at Alamogordo between July 9 and 12.

MOVEMENTS

Attempts to learn the distance of dispersal of deer-mice by the use of nest boxes failed, presumably because there were so many natural refuges available that the nest boxes did not appeal to the mice. The only records of movements of deer-mice from one home range to another were obtained when individuals moved from one of the trapping plots to another or when we set temporary lines beyond the limits of the plots. The amount of trapping that could be done outside of the plots was limited by the extensive nature of the trapping plots.

Such records of movements as are available are extremely interesting and give an indication of how far deer-mice sometimes may move. A young adult female appeared on plot A on May 1 and stayed until May 6. On May 8 she appeared on plot B, approximately 2000 feet away. On May 9 she was back on plot A, where she stayed until May 16. On May 18 she was back on plot B, where she stayed until May 23. On May 24, the last day of trapping, she was back on plot A. This female, therefore, made two round trips between the two plots, traveling a distance of about 2000 feet each time she moved from one plot to the other. Another female, an adult, appeared on plot A on April 15 and stayed until April 18. On April 20 she appeared about 2300 feet away on plot B, where she stayed until the end of trapping on May 24. Another adult female that moved away from plot A was caught in a trap about 1200 feet from where she previously had resided on the plot.

An adult male resident of plot A was caught in a trap about 1200 feet away. Another adult male appeared on plot A on March 19 and stayed until March 21. On March 23 he was caught in a trap about 1300 feet away. On March 24 he was back on the plot, but on March 29 he again was caught about 1300 feet away. This animal never was caught again.

The available data on movements indicate that journeys of more than one-third of a mile are not uncommon.

Peromyscus leucopus tornillo

Eight wood mice were trapped on plot A during April and May, whereas none had been caught there in March. Eleven wood mice were taken on plot B during April and May, but three of them previously had been recorded on plot A. The records of these animals not only provide interesting information about the movements of this species but give some indication of the size of the home range.

HOME RANGES

The size of the calculated home ranges of the mature wood mice that were caught seven or more times is listed in Table V. Most of these indi-

TABLE V
CALCULATED HOME RANGES OF ADULT WOOD MICE (*Peromyscus leucopus tornillo*)
IN MESQUITE ASSOCIATION, APRIL AND MAY, 1940

Sex	Field No.	Month	Number of Times Caught	Last Capture on Which Size of Home Range Increased	Size of Home Range in Acres
♂	173	April	7	.....	1.7
♂	262	April	7	6	3.3
♂	262	May	14	.....	3.4
♂	414	May	9	.....	4.2
♀	274	April	7	.....	3.5
♀	139	May	20	17	5.5

viduals probably were caught too few times to indicate the full extent of their home ranges. The largest home range of a mature male comprised 4.2 acres after the animal had been taken nine times. The largest home range of a female comprised 5.5 acres after she had been trapped twenty times. The size of her calculated home range failed to increase with the last three captures. It is interesting that one male had almost equal-sized calculated home ranges in both April and May, even though he was caught only seven times in April contrasted to fourteen times in May.

The four home ranges of mature male wood mice averaged 3.1 acres. The two home ranges of mature females averaged 4.5 acres. Such data as are available suggest that, in the mesquite association, the wood mice have home ranges of approximately the same size as those of the deer-mice. The range of these wood mice in the mesquite association is much larger than the range of the subspecies *noveboracensis* in the oak-hickory association of southern Michigan (Burt, 1940: 26).

POPULATIONS AND CONCENTRATIONS

No wood mice were caught on plot A during the month of March. Two mature females and three mature males appeared on this plot during the first half of April. During this period there was an average of 0.13 wood mice per acre. Most of the wood mice soon disappeared, and in the three

remaining half-month periods the average number of wood mice per acre varied from 0.05 to 0.10 individuals. On plot B there was one mature male, or an average of 0.06 individuals per acre, in the first half of April. In the three subsequent half-month periods there was an average of, respectively, 0.13, 0.11, and 0.19 individuals per acre. All of the wood mice were adults except one juvenile male taken on plot B in late May.

The trap records of both plots indicate that the wood mouse was relatively scarce in the mesquite association. In the Tularosa Basin the wood mouse reaches its greatest abundance in the grassy wash association. In the fall of 1938, by rough estimate, there were from ninety to one hundred wood mice per acre of grassy wash association near Tularosa (Blair, 1941*d*). In the spring of 1940, twenty-four wood mice were trapped from not more than ten acres of grassy wash association near Alamogordo in less than a week.

The greatest concentration of wood mice on plot A was in the first half of April, when there was an average of 0.22 females and 0.25 males per their respective, average home-range areas. On plot B the greatest concentration of females was in the last half of April and in all of May, when there was an average of 0.22 adult females per home-range area. The greatest concentration of male wood mice on plot B was in the last half of May, when there were 0.35 mature and 0.09 immature males per home-range area.

Of the sixteen wood mice recorded from the two plots, the males outnumbered the females three to one, twelve males and only four females.

BREEDING

The male wood mice for the most part gave evidence of sexual activity during the two months, April and May, that they were living on the plots. In April one of two males examined in the first trap period was sexually active, two of three in the second period, all of four in the third, and two of three in the fourth period were active. In May both of two males in the first period, both of two in the second, all of four in the third, and two of three in the fourth period were sexually active. In addition, one juvenile male in the fourth May period had enlarged testes, which indicates that breeding may begin before the juvenile coat is lost.

Of the five adult female wood mice, one appeared pregnant about the middle of April and again near the middle of May. Another appeared pregnant about the first of May. The three other females indicated potential breeding by their prominent mammae, but they were not trapped over a sufficiently long period to determine whether or not they became pregnant.

MOVEMENTS

No wood mice were taken on plot A during twenty-eight days of trapping in March. During April four adult males and two adult females appeared on this plot, and two more adult males appeared there during May. The

first male was caught on April 1, and another appeared the next day. The first male stayed seven days on the plot, then disappeared. The second stayed only two days before disappearing. Two adult females were caught on plot A on April 7. One of these was last caught on plot A on April 13 and appeared on April 15 about one-half mile away, on plot B, where she remained until April 21. The other female stayed on plot A until April 13, then disappeared, but reappeared on May 7 and 8. An adult male appeared on plot A on April 10 and remained until April 13. This animal appeared on plot B, about one-half mile away, and remained until April 23 when it died in a trap. It is interesting that this male and one of the females disappeared from plot A on the same date and that both appeared on plot B two days later. Possibly, they traveled together in moving from one plot to the other. Another adult male appeared on plot A on April 16 and stayed until April 26. One adult male appeared on plot A on May 10 and stayed until May 12. This animal appeared on plot B, about one-half mile away, on May 14 and stayed until the end of trapping. A young adult male apparently passed through plot A on May 16, for it was taken there only once.

One immature and seven adult wood mice moved to plot B in addition to the three adults that moved there from plot A. No wood mice apparently resided on the plot when trapping was begun; none was taken there during the first six days of April. An adult male transient was recorded on April 7. An adult male appeared on April 10 and stayed until May 16. An adult female appeared on April 13 and stayed until April 25. An adult male was first taken on April 15 and was last taken on May 20. Another adult male appeared on May 1 and disappeared after May 3. One adult female was on the plot from May 10 to 12. An adult male appeared on May 19 and remained until the end of trapping. An immature male appeared on plot B on May 20 and disappeared after May 22.

The trap records of the wood mice seem to indicate nomadic tendencies for this species in the mesquite association during April and May. The movements of the deer-mice to the plots and away from them were not dispersal movements of young animals. Rather, they were, with one exception, movements of fully mature breeding animals that appeared to be at least six months or more of age. The movements to both plots represented invasion of areas that were, so far as known at that time, uninhabited by the species. Some of the wood mice settled there more or less permanently. Some others established residence for rather short periods of time. Others merely passed through the plots. The movement of three individuals from one plot to the other indicates that movements of as much as one-third to one-half mile are not uncommon in this species. The fact that in all three interplot movements one night elapsed between the capture of the mice on plot A and their capture on plot B gives an indication of the speed of travel of the wood mice. The fact that one male and female moved from one plot to the other at the

same time possibly indicates that wood mice sometimes travel in pairs in moving from one area to another.

Citellus spilosoma major

No attempt was made to mark and study the movements of the spotted ground squirrels of the mesquite association. These animals, being diurnal, got into the traps only occasionally. Those that were caught were removed from the area for a study of their pelage color. Ten individuals, of which seven were males and three were females, were trapped on and near plot A. None was caught on plot B. It seems unlikely that all of the ground squirrels living on plot A were caught, nor is it safe to assume that none was living on plot B. The available data, however, point to a greater concentration of ground squirrels on plot A than on plot B.

A female that was trapped on the White Sands gave birth to six young on May 14.

Perognathus penicillatus eremicus

This pocket mouse was fairly numerous on both plots. Sixty-seven individuals were caught on plot A, and thirty-three were recorded on plot B. The trap records provide information about the size of the home ranges, population density, and breeding season of these pocket mice.

HOME RANGES

So many pocket mice died of cold in the traps that only a small fraction of all those on the plots were caught a sufficient number of times to indicate the size of their home ranges. Ten ranges of mature males, based on an average of 14.7 catches each per month, averaged 2.72 ± 0.48 acres. The largest home range of a male comprised 5.54 acres in May; the smallest, 1.23 acres in the same month. The home ranges of six mature females that were caught an average of 12.7 times per month averaged 1.09 ± 0.14 acres. The largest home range of a female comprised 1.43 acres in May; the smallest 0.52 acres in the same month. The home ranges of the mature male pocket mice averaged significantly larger than those of the females, for the difference in the means is 1.63 ± 0.50 acres.

With eleven mature females on plot A in March, the known home ranges of three overlapped rather broadly. In two instances two different females were in the same trap on consecutive nights. In April the nine known home ranges and fractions of home ranges of mature females on plot A failed to overlap, with one exception in which there was a slight overlapping of two ranges. In May, on the same plot, there were twelve mature females, and in only one case was there even a slight overlapping of home ranges. On plot B there was no overlapping of the six known ranges of mature females in April, nor of the ranges of eleven females in May. It appears probable that the home ranges of the mature female pocket mice are mutually exclusive during the breeding season. In March, when there was little evidence

of sexual activity, the known home ranges of females did overlap to some extent. In April and May, after the onset of the breeding season, the ranges of females showed virtually no overlap.

The home ranges of the mature male pocket mice broadly overlapped during every month of trapping on the two plots. It seems evident, therefore, that the home ranges of the males are not mutually exclusive either in or out of the breeding season. The home ranges of the males broadly overlapped those of the females.

POPULATIONS AND CONCENTRATIONS

The population of pocket mice on plot A was lower in the first half of March than at any other time during the study. In this period there were seven males and three females or an average of 0.29 individuals per acre. The population of pocket mice on plot A reached its greatest density in the first half of May, when there were ten females and fifteen males, an average of 0.77 individuals per acre. On plot B the smallest population was recorded in the first half of April, when there were three males and one female, an average of 0.14 individuals per acre. The largest population on plot B was found in the last half of May, when there were nine females and thirteen males, an average of 0.70 individuals per acre.

The greatest concentration of female pocket mice was on plot A in the last half of March, when there was an average of 0.41 individuals per average home-range area. The concentration of females on plot A was at a low of 0.11 individuals per home-range area in the first half of March and the last half of April. On plot B the greatest concentration of females was in the last half of May, when there were 0.35 females per average home-range area. The least concentration of females on plot B, an average of 0.04 individuals per home-range area, was in the first half of April. It is evident that at no time during the trapping were the female pocket mice greatly concentrated on either plot, for there always was an area equivalent to at least two or more average home ranges available for every female recorded on the plots.

The concentration of adult male pocket mice on plot A averaged less than one individual per home-range area only in the first half of March, when there was a low of 0.52 males. In the last half of March the concentration was up to 1.04 males per home-range area, and in the first half of April it reached a high of 1.38 individuals. On plot B the concentration of males was low during April, with averages for the half months of, respectively, 0.24 and 0.55 males per home-range area. In May the concentration of males on plot B averaged 1.02 individuals per home range. It is obvious that the male pocket mice were consistently more concentrated on both plots than were the females, for after the middle of March on plot A and after the first of May on plot B there was an average of at least one male per home-range area.

Cahalane (1941: 62) calculated that there was an average population of

9.9 individuals of this species in an area of mesquite and grass in the San Simon Valley, Arizona, in late August, 1933. He pointed out, however, that the size of the home range, which is necessary for determining the area effectively trapped, was not known. If the area effectively trapped in his work is determined from the average home ranges on my plots, his average of 9.9 individuals per acre drops to 3.2 per acre.

Of the total pocket mice trapped on my two plots, thirty-nine (39 per cent) were females and sixty-one (61 per cent) were males. The excess of males is accounted for in part by the fact that, because of their larger home ranges, males were caught from greater distances from the actual trapping areas than were females. This error is, in large part, eliminated by calculating the sex ratio from the average number of individuals of each sex per acre effectively trapped. On this basis the female pocket mice comprised 44.3 per cent and the males 55.7 per cent of the average number of individuals caught per acre. The remaining discrepancy between the number of males and females probably is accounted for by the greater wandering tendency of the males.

BREEDING

The testes of the male pocket mice examined in March were mostly small or medium in size, which indicated that the breeding season was then just beginning. In April and May the testes of the males examined were mostly large and indicative of general reproductive activity. No sexual activity of females was noted until the trap period of April 19 to 25, when one of four females examined appeared to be pregnant. There was increased evidence of sexual activity of the females in May. Among twenty-three females examined in May, nine had vaginal plugs that indicated recent copulation, and five others appeared to be pregnant.

Perognathus flavus flavus

This little pocket mouse was one of the rarest species of the mesquite association, and only three individuals, of which one previously had been released near by, were recorded on the two plots. An adult male was taken on May 11 on plot B, and an adult female was taken 180 feet distant on May 15. The condition of the mammae of the female indicated that she recently had suckled young, and the enlarged testes of the male showed that he was in breeding condition.

An adult female that had been trapped on the White Sands was released near plot A. This individual later was caught on plot A, about 1200 feet from the point of release. Ten days after the first recapture it again was trapped on plot A about 400 feet from the point at which it first was retaken.

Dipodomys ordii ordii

The five-toed kangaroo rat was the most abundant species of mammal on plot A, where eighty-four were trapped in three months. On plot B, where

only twenty-eight were caught in two months, this species was exceeded in abundance by the four-toed kangaroo rat, by the deer-mouse, and by a pocket mouse.

HOME RANGES

As the home ranges of the male five-toed kangaroo rats did not vary significantly from month to month, the home ranges for the three months have been combined to show the average size of the male ranges. Thirty-two home ranges of mature males caught an average of 17.1 times per month averaged 3.41 ± 0.25 acres.

The largest home range of a male comprised 6.93 acres in May, and the smallest comprised only 0.51 acres in April. The amount of month to month variation in the home ranges of individual males is shown by the records of four males that were caught frequently in all three months. One male had a calculated range of 3.42 acres in March, 3.44 acres in April, and 2.79 acres in May. Another had a range of 3.63 acres in March, 3.82 acres in April, and 2.73 in May. A third male had a range of 1.18 acres in March, 2.73 acres in April, and 2.61 acres in May. A fourth had a range of 4.59 acres in March, 3.50 acres in April, and 5.02 acres in May.

The three home ranges of mature females recorded for March were so much smaller than most of those for April and May that they have been treated separately. The March ranges averaged 1.09 ± 0.36 acres, and the twenty-three ranges for April and May averaged 3.29 ± 0.47 acres. The difference between the two means is 3.7 times its standard error, a difference of 2.20 ± 0.59 acres. The mature females whose ranges were calculated were caught an average of 16.0 times each month.

The largest home range of a mature female comprised 10.41 acres in May. The smallest comprised 0.32 acres in March. This is indicative of considerable individual variation in home-range size. The amount of month-to-month variation in the size of the home range of an individual female is shown by the ranges of one female that was caught in all three months. In March the range of this animal comprised only 0.32 acres, in April, 2.27 acres, and in May, 3.38 acres. The average home ranges of the females in April and May did not differ significantly in size from those of the males.

The home range of each male and female usually was in the same general place so long as the animal was on the plot. The fluctuations in size of range generally were due to fluctuations in the limits of the range, rather than to an actual change of range from one locality to another.

The home ranges of breeding animals of both sexes broadly overlapped the ranges of other members of both sexes. In spite of the fact that several individuals of the same sex were living in the same general area, some parts of both plots were unoccupied by this species. The concentration of these kangaroo rats in certain places, while near-by areas were untenanted, was most striking on plot B. Most of the five-toed kangaroo rats were con-

centrated on roughly one-third of the plot, but approximately one-half of the plot had none of this species.

POPULATIONS AND CONCENTRATIONS

Five-toed kangaroo rats were much more numerous on plot A than on plot B. Consequently, the average populations of this species per acre on the two plots have been treated separately (Table VI). On plot A the greatest number of mature females occurred in the last half of April, when there was an average of 0.51 individuals per acre. On plot B the maximum number of mature females was present in the last half of May, when there was an average of only 0.25 per acre. Thus, the maximum population of mature females on the former plot was approximately twice that on the latter.

TABLE VI

AVERAGE POPULATIONS OF FIVE-TOED KANGAROO RATS (*Dipodomys ordii ordii*) PER ACRE ON EACH OF TWO PLOTS IN THE MESQUITE ASSOCIATION

Plot A	March 4-16	March 17-29	April 1-12	April 13-25	April 30- May 11	May 12-24
Mature ♀	0.24	0.20	0.35	0.51	0.40	0.40
Mature ♂	0.46	0.49	0.71	0.63	0.58	0.61
Immature ♀ .....	.....	.....	0.03	0.03	0.03	0.11
Immature ♂ .....	.....	.....	0.03	0.03	0.05	.....
Totals	0.70	0.69	1.12	1.20	1.06	1.12
Plot B	Not Trapped					
Mature ♀			0.16	0.14	0.19	0.25
Mature ♂			0.14	0.14	0.14	0.16
Immature ♀ .....			.....	.....	0.05	0.03
Immature ♂ .....			.....	.....	0.08	0.03
Totals			0.30	0.28	0.46	0.47

Mature males on plot A were most abundant in the first half of April, when there was an average of 0.71 individuals per acre. On plot B the maximum number of mature males occurred in the last half of May, when there was an average of only 0.16 individuals per acre. It is evident that mature males were from four to five times as abundant on the former as on the latter plot in every period in which the two were compared.

The unequal proportions of males to females on the two plots are extremely interesting. On plot A there always were more males than females, and in three of the periods males exceeded females two to one. On plot B the females equaled or exceeded the males in abundance in every trapping period. It is evident that in this species at least marked local fluctuations in the sex ratio may occur. The condition observed here is unusual in small mammals. Generally, the sex ratio is even, or the males are slightly more numerous than the females.

Immature five-toed kangaroo rats were not numerous on the plots. The

greatest number of immatures of both sexes were on plot B during the first half of April, when there was an average of 0.13 immatures per acre. The greatest average of five-toed kangaroo rats of all sexes and ages occurred on plot A during the last half of April, when there was an average of 1.20 individuals per acre. On plot B the maximum was reached in the last half of May, when there was an average of 0.47 five-toed kangaroo rats per acre.

The average number of five-toed kangaroo rats of the several sex and age classes per home-range area is shown in Table VII. The greatest concentration of mature females was on plot A in the last half of April, when there was an average of 1.67 females per home-range area. Mature males were most concentrated on plot A during the first half of April, when there was an average of 2.43 individuals per home-range unit. Immatures were not very heavily concentrated, for the average was no more than a small fraction of one individual per home-range area.

TABLE VII
AVERAGE NUMBER OF FIVE-TOED KANGAROO RATS (*Dipodomys ordii ordii*) PER HOME-RANGE AREA ON EACH OF TWO PLOTS IN THE MESQUITE ASSOCIATION

Plot A	March 4-16	March 17-29	April 1-12	April 13-25	April 30- May 11	May 12-24
Mature ♀	0.26	0.22	1.14	1.67	1.32	1.32
Mature ♂	1.58	1.67	2.43	2.16	1.98	2.07
Immature ♀ .....	.....	.....	0.09	0.09	0.09	0.35
Immature ♂ .....	.....	.....	0.09	0.09	0.18	.....
Plot B	Not Trapped					
Mature ♀			0.54	0.45	0.63	0.81
Mature ♂			0.46	0.46	0.46	0.56
Immature ♀ .....			.....	.....	0.18	0.19
Immature ♂ .....			.....	.....	0.28	0.09

BREEDING

The breeding season of *ordii* evidently started shortly before trapping was begun in early March, for no young of the year were caught before early April. That breeding still was in progress when trapping was discontinued in late May was shown by the sexual condition of the animals living on the plots. Fall and early winter breeding of this species in southern New Mexico is indicated by a breeding male collected on October 11, 1938, also by records published by Bailey (1931: 268). Whether breeding continues throughout the summer or is broken into spring and fall periods is not yet known.

In each trapping period 84 to 100 per cent of all of the males on the plots were sexually active, as indicated by their enlarged testes. Immature as well as adult males are included in these calculations, for several of the juvenile and subadult males had large testes in the scrotum.

Three criteria of sexual activity of female kangaroo rats were used. Late

stages of pregnancy were indicated by the distended abdomen. Females that were suckling young indicated this fact by the condition of their mammae. In addition, a gelatinous plug that forms in the vagina of female kangaroo rats following copulation was an excellent indicator of sexual activity. This last phenomenon previously has been described for the species *Dipodomys spectabilis* by Vorhies and Taylor (1922: 17).

At some time during March eight (89 per cent) of the nine females examined either were suckling young, apparently pregnant, or exhibited a vaginal plug. In April twenty-nine (94 per cent) of the thirty-one females examined at some time exhibited one or more of the criteria of sexual activity. In May twenty-nine (88 per cent) of the thirty-three females examined were at one or more times pregnant, lactating, or had recently copulated. Several juvenile and subadult females were found with vaginal plugs which, with the breeding of immature males, proves that the five-toed kangaroo rats like many other rodents become sexually active long before they are fully grown.

Two females that were caught frequently in all three months apparently gave birth to, respectively, three and four litters. The first of these females had a vaginal plug in the first March period and was pregnant, near term, in the first April period. In the third April period she again appeared pregnant, and in the first May period she was suckling young. In the third May period she again appeared to be pregnant. The other female was suckling young when first caught in the second period of March. She had a vaginal plug in the third and fourth March periods, and appeared pregnant in the first April period. She again appeared pregnant in the last April period and on April 23 gave birth, in a trap, to two young. She again appeared pregnant in the last May period. Eleven of the females that were caught in two months gave evidence of copulating at least twice during that period, and in several of these cases two litters evidently were produced.

In some of the females the vaginal plug persisted for a long time without any discernible evidence of pregnancy. One female had a recent plug when first examined in the first April trap period, and she subsequently had a plug in every trapping period until the work was discontinued on May 24. It is not certain that the same plug persisted throughout this entire period. Rather, it seems quite possible that copulation took place several times. Other females had vaginal plugs that persisted almost as long as in this example. In some cases a plug persisted for a considerable period, and then was replaced by an obviously later one.

All of my observations of breeding of the five-toed kangaroo rat in southern New Mexico indicate a high rate of increase of the species there. There is a breeding season of at least three months in the spring, and there is at least some reproduction in the fall. In the spring most mature females produce at least two, and sometimes more, litters of young. Furthermore, the young of the year begin breeding long before they reach adult size, thus

augmenting greatly the multiplication of the species during the spring season. The rapid rate of reproduction indicated for this species contrasts markedly with the "surprisingly low rate of reproduction" for which Vorhies and Taylor (1922: 18) found evidence in another species (*Dipodomys spectabilis*).

MOVEMENTS

Only one record of the distance of a movement of a five-toed kangaroo rat, other than within the home range, was obtained. A subadult female appeared on plot B on May 8. This animal appeared on plot A, some 2000 feet distant, on May 9 and stayed until May 11, after which it was not taken again.

Dipodomys merriami ambiguus

The four-toed kangaroo rat was the most abundant species of mammal on plot B, where seventy-four individuals were caught in two months. On plot A, where seventy were trapped in three months, it was exceeded in abundance only by the five-toed kangaroo rat (*Dipodomys ordii*).

HOME RANGES

The home ranges of mature males of this species, like those of the five-toed species, did not vary significantly in size from month to month. Consequently, all of the home ranges of mature male *merriami* have been combined to determine the average home-range size. The average of fifty-seven home ranges of males, based on an average of 16.6 captures per month, was 4.07 ± 0.24 acres. The largest home range of a male comprised 8.78 acres in May. The smallest comprised 1.18 acres in April.

Usually, each of these kangaroo rats, like individuals of most of the other species on the plots, remained in one general locality, although the exact limits of each calculated home range fluctuated somewhat from month to month. Calculated home ranges are available for four males in each of the three months of trapping. The male that exhibited the greatest monthly difference in home-range size had a calculated range of 6.44 acres in March, 3.14 acres in April, and 1.95 acres in May. His range in March was 4.49 acres larger than the area over which he was known to have ranged in May. The male with the least monthly variation in home-range size had a calculated range of 2.41 acres in March, 2.83 acres in April, and 3.08 acres in May. His range was only 0.67 acres larger in May than it was in March.

The home ranges of mature females, like those of the five-toed species, averaged considerably smaller in March than in the two following months. Therefore, the March home ranges have been treated separately from the others. In March eight home ranges, based on an average of 14.5 captures, averaged 1.94 ± 0.22 acres. In April and May twenty-seven home ranges, based on an average of 18.3 captures, averaged 3.88 ± 0.51 acres. The March ranges were significantly smaller than those for April and May, the

difference in the means being 1.94 ± 0.55 acres. Although the number of March ranges was small for both species of kangaroo rats, the parallel condition in the two species lends weight to the evidence that those females ranged over smaller areas in March than in the later months. Data now available do not suffice to account for the small size of the female home ranges in March.

The largest home range of a female comprised 12.52 acres in April. The next largest comprised 11.81 acres in the same month. The smallest comprised only 1.17 acres in May. The range of variation in home-range size is greater than in any other small mammal of which I know. The third largest range comprised only 5.89 acres. The two largest ranges are puzzling, because they so greatly exceed the other female ranges. The large calculated range of one of these females possibly was due to a shift in range, as the animal never again was taken on the particular part of the plot on which it first was caught. No such possible explanation can be given for the other large range, and it seems probable that this merely was an unusually wide-ranging individual.

There was no significant difference in size between the home ranges of the male *merriami* and the April-May ranges of the females. Neither was there any significant difference between the ranges of the *merriami* and those of the species *ordii*.

Four immature females, caught an average of 14.2 times each, had an average home range of 4.56 acres. No immature males were caught a sufficient number of times to indicate the size of their home ranges.

The home ranges of both males and females broadly overlapped others of the same sex on both plots in every month of trapping.

POPULATIONS AND CONCENTRATIONS

The four-toed kangaroo rat was approximately equal in abundance on both of the trapping plots. Consequently, the population data for the two plots have been combined to show the average number of individuals per unit area at that season of the year (Table VIII). The greatest density of mature females was in the last half of May, when there was an average of 0.45 indi-

TABLE VIII

AVERAGE POPULATIONS OF FOUR-TOED KANGAROO RATS (*Dipodomys merriami ambiguus*) PER ACRE IN MESQUITE ASSOCIATION. TWO PLOTS COMBINED

Class	March 4-16	March 17-29	April 1-12	April 13-25	April 30- May 11	May 12-24
Mature ♀	0.24	0.27	0.33	0.35	0.39	0.45
Mature ♂	0.39	0.46	0.56	0.50	0.47	0.46
Immature ♀ .....	.....	.....	.....	0.01	0.07	0.11
Immature ♂ .....	.....	.....	0.02	.....	0.03	0.06
Totals	0.63	0.73	0.91	0.86	0.96	1.08

viduals per acre. The greatest density of males was in the first half of April, when there was an average of 0.56 males per acre. The number of immatures of this species per acre was low in every period, and none was taken in either March period. The greatest number of immatures was taken in the last half of May, when there was an average of 0.11 immature females and 0.06 males, or 0.17 of both sexes combined per acre. The greatest density of all age and sex classes of the species likewise was found in the last half of May, when there was an average of 1.08 four-toed kangaroo rats per acre.

The average number of the several classes of this species per their respective, average home-range areas is shown in Table IX. Mature females

TABLE IX

AVERAGE NUMBER OF FOUR-TOED KANGAROO RATS (*Dipodomys merriami ambiguus*) PER HOME-RANGE AREA IN THE MESQUITE ASSOCIATION. TWO PLOTS COMBINED

Classes	March 4-16	March 17-29	April 1-12	April 13-25	April 30- May 11	May 12-24
Mature ♀	0.46	0.52	1.30	1.34	1.49	1.74
Mature ♂	1.58	1.88	2.32	2.06	1.90	1.86
Immature ♀ .....	.....	.....	.....	0.05	0.33	0.50
Immature ♂ .....	.....	.....	0.05	.....	0.10	0.26

reached a maximum concentration of 1.74 individuals per home-range area in the last half of May. Mature males were more concentrated than mature females and reached a maximum concentration of 2.32 individuals per average home-range area in the first half of April. Immatures never were very much concentrated. The greatest concentration of immature females was in the last half of May, when there was an average of 0.50 individuals per home-range area. Immature males reached a maximum of 0.26 individuals per home-range area in the same period.

Monson and Kessler (1940: 40) counted *merriami* dens on one-acre plots in creosote bush association in Arizona and by excavating on some of them found that there was an average of one *merriami* to 4.11 dens. There were an average of 31.3 dens per acre, which, by their rat-den ratio, gives an average of 7.6 individuals per acre. Their data, however, are not comparable with mine because their averages apparently cover a period of more than a year, and, consequently, take no account of seasonal fluctuations in abundance, nor, so far as I can see, in seasonal differences in the rat-den ratio.

Cahalane (1941: 62) calculated that there was an average of 3.2 individuals per acre in an area of mesquite and grass in the San Simon Valley, Arizona, in late August, 1933. If the area, however, that he was trapping effectively is calculated from my home-range data, his average drops from 3.2 to 0.9 individuals per acre.

BREEDING

The breeding season of *merriami* did not begin until early March, after

trapping was initiated. The first immature was not taken until the first trap period in April, and no other was taken until after the middle of that month. Breeding still was in progress when field work was discontinued in late May.

The breeding season of the *merriami* began somewhat later than that of *ordii*. In eight (73 per cent) of eleven males examined in the first period in March, the testes were sufficiently large to be discernible. In only two individuals, however, had the testes attained the large size characteristic of peak breeding activity. Evidence of sexual activity of males increased in the second March period, when 79 per cent were in breeding condition. In subsequent periods from 86 to 100 per cent of the males examined in each trap period were sexually active.

Not only did the breeding season begin later than in *ordii*, but there was never so large a fraction of the females on the plots breeding at one time as in the other species. In March only three (27 per cent) of the eleven females examined evidenced sexual activity. Two of these had vaginal plugs on March 20, and the other had a vaginal plug on March 23. This is in considerable contrast to the 89 per cent of breeding female *ordii* in March. In April eighteen (50 per cent) of thirty-six female *merriami* at some time showed evidence of breeding, in contrast with the 94 per cent of breeding female *ordii* in the same month. In May thirty-three (67 per cent) of the forty-nine *merriami* females examined were at some time sexually active, compared with 88 per cent of active *ordii*.

Eleven females indicated by their vaginal plugs that they copulated at least twice during the period of trapping. There was evidence that at least three of these females gave birth to two litters. Most of the juvenile and subadult females appeared with vaginal plugs. Likewise, most of the juvenile and subadult males developed large testes before they were grown. This indicates that, like *ordii*, the species *merriami* becomes sexually active long before it matures in size.

Specimens preserved in alcohol in the collection of the University of Michigan Museum of Zoology indicate that breeding continues well into the summer and that there is at least some breeding in the fall. Among twelve males from the same area, dated July 3 to 15, 1927, nine (75 per cent) were sexually active when killed. Of twelve females, six (50 per cent) were sexually active when killed. Two of these females contained two embryos each, three evidently had recently suckled young, and one young adult had a vaginal plug. Of two males from Carlsbad, Eddy County, dated August 12 to 16, 1926, an adult had large testes; a half-grown male had small. Of two females from the same place and collected at the same time, an adult was not sexually active, but a half-grown female had a vaginal plug. Among seven specimens collected near Alamogordo on October 11, 1938, two adult males were sexually active; three adult males and two adult females showed no sign of breeding. All of the available evidence indicates that *merriami*,

like *ordii*, has a much more rapid rate of reproduction than Vorhies and Taylor (1922: 18) found in *spectabilis*.

MOVEMENTS

Only two records of the distance of movements of four-toed kangaroo rats from one area to another were obtained. A young adult male was caught once on plot B on May 11. This animal appeared about 2000 feet away on plot A on May 18, where it was taken only once before it disappeared. Another young adult male appeared on plot A on May 13 and stayed until May 20. On May 22 it was caught about 2700 feet away on plot B, but it disappeared after being caught there once.

Onychomys leucogaster ruidosae

The grasshopper mouse was rare and unevenly distributed in the mesquite association. Only five individuals were taken during three months of trapping on plot A, and none was taken in two months on plot B. The trap records of the five grasshopper mice, however, provide some very worth-while information about the species.

HOME RANGES

Only one grasshopper mouse was trapped more than ten times in a month, and for only three individuals did the size of the known home range fail to increase with the last capture of the month (Table X). Therefore, some of

TABLE X

CALCULATED HOME RANGES OF GRASSHOPPER MICE (*Onychomys leucogaster*) MARCH, APRIL, AND MAY, 1940

Ranges that increased with last capture possibly incomplete

Age	Sex	Field No.	Month	Number of Times Caught	Last Capture on Which Size of Home Range Increased	Size of Home Range in Acres
Ad.	♂	41	April	9	6	3.8
Ad.	♂	41	May	16	14	4.8
Subad.	♂	68	March	8	.....	11.4
Yg. ad.	♂	68	April	8	7	6.6
Yg. ad.	♂	68	May	7	.....	8.0
Ad.	♀	71	March	6	.....	1.5
Ad.	♀	71	April	6	.....	2.1

the calculated home ranges probably represent only a fraction of the actual range. Several nights often elapsed on which one or another of these grasshopper mice was not caught. This possibly indicates that their ranges extended for considerable distances outside of the plot. Consequently, the calculated ranges should be considered only as minimum ranges. The largest known range was that of a subadult male and comprised 11.4 acres in

March. As a young adult in April and May this individual had notably smaller known ranges of 6.6 and 8.0 acres, respectively.

The average of the two calculated monthly home ranges of the young adult male and of the two monthly ranges of an adult male was 5.8 acres. The average of the two monthly home ranges of an adult female was 1.8 acres. Although the numbers are small the great disparity between the mature male and female averages suggests a possible sexual difference in the size of the home range.

POPULATIONS AND CONCENTRATIONS

The adult male and female grasshopper mice and the one subadult and two juveniles that were trapped on plot A in March possibly represented the parents and the remnants of two of their litters. The two juveniles were not recorded on the plot after March, which possibly indicates dispersal of these individuals. The adult female disappeared after April 16. Whether she fell victim to a predator or moved away I do not know. The original adult male and the young adult that matured there remained on the plot until the end of trapping.

The population per acre was small for all of the periods. The greatest density of population was in the two March periods, in each of which there were only 0.08 individuals per acre. The scarcity of these grasshopper mice on plot A and their absence from plot B indicate that the species was relatively rare and unevenly distributed in the mesquite association in the spring of 1940.

The concentration of the several sex and age classes of grasshopper mice was low in all trapping periods. The greatest concentration was of immature males in the first half of March, when there were 0.38 immature males per average home range. There was no more than a small fraction of one individual per average home range in any sex or age class.

BREEDING

The subadult and juvenile grasshopper mice trapped in March indicated that young were born in January and February. Examinations of the adult female indicated that she bore a litter about the first of April. No young of this litter were caught, and it is possible that they died from neglect while the mother was in a trap. The large testes of the adult male showed sexual activity during the entire trapping time, from early March to late May. Sexual activity of the one individual first caught when a subadult was indicated by enlarged testes while still in juvenile pelage. It still was sexually active when last caught in late May. Bailey (1931: 141) recorded pregnant females of this species from San Pedro and Socorro taken on July 10 and August 19, respectively. Therefore, it seems probable that the breeding season extends at least into late summer.

Onychomys torridus torridus

The scorpion mouse was found on both of the trapping plots. Nine specimens were caught during three months of trapping on plot A, and five were captured in two months on plot B.

HOME RANGES

The calculated home ranges of the scorpion mice are given in Table XI. The largest home range of a mature male comprised 12.4 acres; the smallest,

TABLE XI

CALCULATED HOME RANGES OF SCORPION MICE (*Onychomys torridus*) IN MESQUITE ASSOCIATION, MARCH, APRIL, MAY, 1940

Age	Sex	Field No.	Month	Number of Times Caught	Last Capture on Which Size of Home Range Increased	Size of Home Range in Acres
Ad.	♂	18	March	18	16	8.9
Ad.	♂	36	March	18	15	12.4
Ad.	♂	36	April	10	.....	6.9
Ad.	♂	62	April	22	17	3.1
Ad.	♀	20	March	16	.....	7.7
Ad.	♀	20	April	23	20	6.5
Ad.	♀	20	May	20	.....	7.8
Ad.	♀	53	March	16	15	3.9
Ad.	♀	53	April	20	.....	3.6
Juv.	♀	328	May	11	10	5.2

only 3.1 acres. The largest range was about two-thirds as large as the entire trapping area. The male that had the maximum range of 12.4 acres in March had a range of only 6.9 acres in April. The four monthly ranges of mature males averaged 7.8 acres.

The largest home range of a mature female comprised 7.8 acres, and the smallest, 3.6 acres. The one mature female whose home range in each of the three months is known varied the size of her range within the rather narrow limits of 1.3 acres. Her smallest range comprised 6.5 acres in April; her largest, 7.8 acres in May. The other adult female varied the size of her monthly range by 1.6 acres. Her range equaled 3.6 acres in April and 5.2 acres in May. The five monthly ranges of these females averaged 5.9 acres. One juvenile female that was caught eleven times in May had a calculated home range of 5.2 acres.

POPULATIONS AND CONCENTRATIONS

The maximum population of scorpion mice was on plot A in the last half of March, when there were three mature females and five mature males. This constituted an average population of 0.06 females and 0.10 males per acre, or a total of 0.16 mice of this species per acre. The population on plot B was smaller than that on plot A. There was, on plot B, one mature male and one mature female during the two April periods and the first period of

May. In the last May period there was one adult and one juvenile male. The average population of scorpion mice per acre on plot B comprised 0.04 individuals in every period. This was lower than the average population per acre on plot A in every period except the last one in May, when the averages on the two plots were the same.

The concentration of scorpion mice was not very large, for the average number of individuals of either sex per home-range area never equaled one. The greatest concentration was of mature males in the first half of March on plot A, where there was an average of 0.90 individuals per average home-range area. The greatest concentration of mature females comprised an average of 0.39 individuals per average home-range area in the two April periods and in the first of the May periods on plot A. On plot B the concentration of mature males never exceeded 0.16 individuals per home-range area, and that of adult females never surpassed 0.13 individuals per home-range area.

Cahalane (1941: 62) calculated that there was an average of 2.0 individuals per acre in an area of mesquite and grass in the San Simon Valley, Arizona, in late August, 1933. If the area that he trapped effectively is computed from my home-range data, his average of 2.0 individuals drops to 0.3 individuals per acre.

BREEDING

Sexual activity of the male scorpion mice during the entire trapping time, from early March to late May, was indicated by their enlarged testes. Only one of five males examined in the period of March 11 to 17 appeared not to be in breeding condition. Every other time that a male was examined sexual activity was evident.

Each of the five mature females on the two plots bore one or more litters during the trapping time. Four bore litters about the first of April, and one of these again produced young near the middle of May. A female that was taken only once, on May 10, was pregnant.

The failure to catch any young mice in the early periods of trapping probably indicates that the breeding season did not begin until about the time trapping was begun. In spite of the fact that at least six litters were born on or near the plots, only one immature individual was caught. This possibly resulted from the young dying of neglect while their mothers were in traps.

Bailey (1931: 142) recorded a pregnant female of this species that was taken August 14 at Socorro. It seems probable that the breeding season extends at least into late summer.

Neotoma micropus canescens

The plains wood rat was present on both plots. No systematic trapping of wood rats, however, could be done, because most of the traps were too small to catch these animals. No attempt was made to learn the number of

wood rats on plot A, but on plot B a few large traps were set near wood-rat nests and enabled us to mark all or nearly all of the resident wood rats. The wood rats made a nuisance of themselves by overturning the small traps on the plot, so that they were trapped primarily to deter them from disturbing the regular trapping.

POPULATIONS

At least ten wood-rat nests in use were located on plot A, and at least twenty-one on plot B. On the latter plot fifteen wood rats were trapped during April. Seven of these were mature females, six were mature males, and there was one juvenile wood rat of each sex. In May only eleven wood rats were caught on plot B. Only two of these were previously unmarked. The difference in number caught between the two months probably is due to the unsystematic trapping for these animals rather than to any decrease in population density. The fact that the number of active nests exceeded the number of wood rats caught on plot B possibly indicates that one individual utilizes more than one nest. In this connection, one male and one female were caught near two different nests, one male was taken near three different nests, and one female was captured in the vicinity of four different nests. That a wood rat was caught near a nest is not conclusive proof that it was using that nest. The fact that wood-rat nests were twice as numerous on plot B as on plot A undoubtedly indicates a larger population on plot B.

BREEDING

All of the mature wood rats examined on plot B showed evidence of sexual activity. The three females that were caught between April 1 and 7 were suckling young. Each female subsequently examined either appeared to be pregnant or recently to have suckled young. Two suckling females were trapped near Alamogordo on October 30, 1938.

Bailey (1931: 174) recorded a nursing female that was taken at Ancho on September 23 and a half-grown young taken at Tularosa on November 21. He also listed records of summer breeding which, with my data, seem to indicate a rather continuous breeding season from at least early April until October.

MOVEMENTS

No wood rat was caught a sufficient number of times nor in a sufficient number of places to indicate the size of its home range. One adult male was caught at two points about 920 feet apart, but it is impossible to be sure whether this indicated a normal movement within his home range or a shift of range.

SOCIAL RELATIONS

On three occasions a mature male and female were the only wood rats caught in the vicinity of a given nest. On another occasion a juvenile male and female were trapped near the same nest. Near one nest five different

individuals, three females and two males, were taken during the two months of trapping. A suckling female was taken there on April 5, but she was not caught again. On May 3 a mature male and female were caught at this nest, both of whom had been previously trapped at different near-by nests. On May 14 and 15 a mature female was caught on the plot for the first time near this same nest, and on May 16 a mature male that previously had been caught at a near-by nest was taken at this nest. These records suggest a considerable amount of overlapping in the home ranges of the wood rats.

Mus musculus

An adult male house mouse was trapped in plot A on April 11. It was caught only once and evidently was only passing through the plot. The enlarged testes indicated that this animal was in breeding condition. No other house mouse was caught on either plot.

HOME RANGES OF MESQUITE ASSOCIATION MAMMALS

The features of mammalian home ranges of most concern are the size, relative stability, and the amount of overlapping of the ranges of the same and different sex and age classes, and of the same and different species. The matter of overlapping ranges, since it throws light on the interrelationships of individual constituents of the population, is discussed in the section on "The Mammalian Population of the Mesquite Association."

SIZE

In size, the home ranges of two species of mesquite association mammals, as shown above, generally are larger than those of other races of the same species studied in the blue-grass, beech-maple, and oak-hickory associations of Michigan. The Chihuahua deer-house (*Peromyscus maniculatus blandus*) ranges more widely than do the prairie deer-mouse (*Peromyscus m. bairdii*) of the blue-grass association and the woodland deer-mouse (*Peromyscus m. gracilis*) of the beech-maple association. The desert wood mouse (*Peromyscus leucopus tornillo*) ranges more widely in the mesquite association than does the individual of another subspecies (*Peromyscus leucopus noveboracensis*) in the oak-hickory association of southern Michigan (Burt, 1940: 26). In these species, therefore, there are marked geographical differences in home-range size probably accounted for by obvious differences in the ecological conditions prevailing in the several associations in which these species were studied.

Most of the small mammals except *Peromyscus* of the mesquite association have no close relatives in the other areas in which home ranges have been studied. Therefore, no comparisons of their ranges can be made with those of others of the same species or even of the same genera. The general statement can be made, however, that characteristic desert mammals, as represented by *Dipodomys ordii*, *Dipodomys merriami*, *Onychomys leucogaster*,

and *Onychomys torridus* of the mesquite association, usually have larger home ranges than the characteristic small mammals of the eastern deciduous forest and prairie grasslands (Blair, 1940a, 1940b, 1941c, and 1942). A pocket mouse (*Perognathus penicillatus*) proves an exception to this rule, for this species ranges no more widely than some of the forest and grassland mammals. The woodland jumping mouse (*Napaeozapus insignis frutescens*) also ranges as widely as some of the desert mammals. The exceptionally large range of the woodland jumping mouse possibly is accounted for by its greater morphological adaptation for mobility than is present in other forest inhabitants.

It is extremely interesting and seemingly contradictory to the foregoing observation about the woodland jumping mouse that the presumably most mobile desert mammals, the kangaroo rats, do not have the largest home ranges. The saltatorial kangaroo rats have home ranges of about the same size as the not so well-adapted deer-mice and wood mice. The grasshopper mice and scorpion mice (*Onychomys leucogaster* and *O. torridus*), which appear to be no better adapted for mobility than are the deer-mice and wood mice, have the largest home ranges of the mesquite association mammals. It is possible that, because of their insectivorous habits (Bailey and Sperry, 1929), grasshopper mice and scorpion mice range farther in search of food than do the vegetation eaters.

STABILITY

Each of the mammals of the mesquite association, with the exception of the wood mouse, usually remained in the same general area for a relatively long period of time. The wood mice were definitely nomadic in behavior. One home range was occupied for a short period; then the animal moved on to another. Among the other species each individual that was marked on the plots usually stayed in the same vicinity until the end of trapping, although the limits of its calculated home range varied within usually narrow limits from month to month (Fig. 2). There were, nevertheless, occasional movements of as much as one-third of a mile. In such cases, an animal moved away from an established home range and subsequently came to occupy an entirely different one.

These observations indicate that, in respect to the possible dispersal of hereditary characters through the population, two opposite trends exist. The long-term occupation of limited home ranges by the bulk of the population tends to inhibit the spread of new characters. On the other hand, the occasional movements of some individuals for distances several times the width of a home range facilitates the spread of such characters. Of even more importance in this respect than the occasional movements of mature animals that were observed are the possible movements of young individuals after they leave the nest. No data are yet available, however, on the rate of dispersal of the young of the mammals of the mesquite association.

THE MAMMALIAN POPULATION OF THE MESQUITE ASSOCIATION

The several species of small mammals of the mesquite association have been considered separately in a foregoing section. It is also equally important to consider the total mammalian population of the association as a unit, of which each individual is but one component part.

SIZE OF POPULATION

The average total population of all small mammals, as shown by the trap records, reached a high of 3.64 individuals per acre on plot A in the first half of May. The average for all of the "half-month" periods on this plot comprised 3.24 individuals per acre. A high of 3.19 individuals per acre was reached on plot B in the last half of May. The average for all of the four "half-month" periods on plot B was 2.51 small mammals per acre. These totals, of course, do not include forms that were too large for the traps, such as cottontails, jack rabbits, and wood rats, nor the diurnal ground squirrels.

The total populations of mesquite association mammals seem rather small. Actually, the mammalian population probably was at its lowest point of the year when trapping was begun. A period of sexual inactivity of most of the species ended at about the start of the field work. During that period, when no young were being produced, losses from the population were not balanced by births. The population normally reaches a low just before young animals begin to appear in the spring, and normally reaches a maximum toward the close of breeding in late fall or early winter. No census study of the mesquite association mammals has been made at the season when one would expect to find a peak of abundance. I noted, however, that small mammals seemed much more numerous during extensive trapping in the mesquite association in the fall and in the early winter of 1938 than they were in the spring of 1940.

INTERRELATIONSHIPS OF THE MAMMALS

Since the observational method is not applicable to these small, nocturnal mammals, knowledge of the relationships between individuals and between species is limited to the information supplied by the trap records. Chihuahua deer-mice and four-toed and five-toed kangaroo rats appeared tolerant of their own kind, for their calculated home ranges broadly overlapped the ranges of others of the same species and sex. Breeding female pocket mice (*Perognathus penicillatus*) evidently were intolerant of one another, for their home ranges scarcely overlapped. Of the remaining species, too few individuals were caught to show adequately the amount of overlapping of their home ranges. It is obvious, nevertheless, that the species making up the bulk of the population, the deer-mice and the kangaroo rats, were tolerant of their own kind.

Concerning the relationships between the several species, it is known that the ranges of all overlapped one another indiscriminately. Because of the

rather large home ranges of the mesquite association mammals, each individual in its normal travels must, on the average, come in contact with from ten to fifteen other individuals of its own kind and of other species. Nothing is known of what actually happens when an individual encounters another of the same or of a different species. There can be no doubt, however, that some *modus vivendi* has been established whereby numerous individuals of several species occupy the same terrain.

Tappe (1941: 145) believed that other small mammals were scarce in areas inhabited by *Dipodomys heermanni tularensis* because of competition for food from that species of kangaroo rat. No evidence of such severe competition was found among the small mammals of the mesquite association. There undoubtedly is competition in the sense that food eaten by one individual is not available for any other individual. There is an almost unlimited supply of mesquite, however, which, in one form or another, appears to be the principal food of most of the small mammals in this association. It is difficult, in fact, to discover any evidence of competition of a critical nature among these small mammals. The number of holes and tunnels so greatly outnumbers these animals that it is hard to believe that there is any great amount of competition for home sites or refuges, at population levels such as obtained during the time of study.

It is particularly interesting that in this association there are three cases of two rather closely related species of the same genus living side by side and actually occupying overlapping home ranges. The best example is afforded by the kangaroo rats (*Dipodomys ordii* and *Dipodomys merriami*). These two mammals are very similar in size and external appearance, and both have, in general, similar habits. The populations of these species in the mesquite association were both of the same general order of magnitude. Locally, either one might exceed the other in abundance. The grasshopper mouse and scorpion mouse (*Onychomys leucogaster* and *O. torridus*) also occupy overlapping home ranges, with the result that individuals of the two species undoubtedly come in contact with one another. The scorpion mice here are more numerous than the grasshopper mice, which show a preference for sandy soil and sand dunes. The deer-mouse and wood mouse (*Peromyscus maniculatus* and *P. leucopus*) occur together here as in many other parts of their range, although the two are to a considerable extent kept apart by their different ecological preferences. There is no evidence of any critical amount of competition between closely related species for food, home sites, or territory.

SUMMARY

The small mammal population of the mesquite association near Alamogordo, New Mexico, was studied by live trapping from March 4 to May 24, 1940; 105 Chihuahua deer-mice and 419 individuals of ten other species were marked and retrapped many times.

The average size of the home ranges of mature males and females was

determined for five species. Some information about home-range size was obtained for two other species, and several facts about the general life history of four other species were learned. Only in the case of the pocket mouse (*Perognathus penicillatus*) did the mature males have significantly larger home ranges than did the females. These pocket mice had the smallest average home ranges of the mesquite association mammals, whereas the scorpion mice had the largest.

Breeding by all of the species of small mammals of the mesquite association was in progress in the spring of 1940. Broad overlapping of home ranges within all sex and age classes occurred in all species except the pocket mouse. In this species the home ranges of mature females did not overlap one another during the breeding season. Occupation of individual home ranges of all species except *Peromyscus leucopus* was relatively permanent, but occasional individuals moved from one home range to another. These movements sometimes were for distances of as much as one-third of a mile.

The four-toed kangaroo rat was the most abundant species on one plot; the five-toed kangaroo rat was the most numerous species on the other. The greatest average number of individuals of all species per acre on either plot was 3.64 in the first half of May. Mature male five-toed kangaroo rats reached the greatest concentration of any sex or age class of any species, for there was an average of 2.43 individuals per average home-range area. A concentration of more than one individual per average home-range area also was found in mature female five-toed kangaroo rats, in mature male and female four-toed kangaroo rats and Chihuahua deer-mice, and in mature male pocket mice (*Perognathus penicillatus*).

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